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Sustainability in Apparel Production Supply Chain

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Abstract –The waste problem has become a non-ignorable issue in apparel industry like other manufacturing industries and the concept of sustainability has come to the forefront. The term 'sustainability' refers to the long-term viability of business operations and their subsequent effects on environmental and social well-being. As it can be understood from the meaning of the term, sustainability is actually contrary to the concept of trend change relevant to fast fashion in apparel industry. Providing a sustainable fashion is difficult because the apparel production supply chain is very complex. The raw material of apparel industry passes from many production processes involving fiber production, yarn manufacturing, fabric production and while passing from these steps, natural resources (water, oil, land) are consumed, toxic chemicals are used, large amounts of carbon dioxide is generated and million tons of wastes come out. In order to obtain sustainable apparel production, all these steps should provide sustainability. From this point of view, in this study, we firstly presented environmental impacts of common raw materials used in apparel manufacturing and their recycling/reclaiming possibilities. In the second part, we discussed the challenges that need to be competed through the apparel supply chain. Finally, perspective of international apparel retailers to the issue of sustainability has been mentioned.
Keywords – sustainability, apparel, eco-fashion, green products, textile industry

I. INTRODUCTION

With the industrial revolution, the manufacturing industry evolved and manual labour systems were replaced by mechanized manufacturing. This mechanization allowed textile especially the apparel industry to produce cheaper, quicker and in vast quantities. Reduced prices led to a further increase in consumption. In 2000 the world's consumers spent around US$1 trillion on clothing [1]. The value of the global women's apparel market reached USD 505 billion in 2015 and is expected to grow at a compound annual growth rate of around 3% during the next five years. The global menswear market totaled USD 418.9 billion in 2015 and is expected to reach USD 522.3 billion by 2020, posting a compound annual growth rate of about 4.8% from 2016 to 2020 [2].

Fashion, the igniter of the apparel industry, embraces obsolescence as a primary goal more than any other industry in the world and fast fashion simply raises the stakes. low cost, fresh design, and quick response times allow for greater efficiency in meeting consumer demand [3].

Fast fashion—low-cost clothing collections based on current, high-cost luxury fashion trends—is, by its very nature, a fast-response system that encourages disposability. Fast fashion companies thrive on fast cycles: rapid prototyping, small batches combined with large variety, more efficient transportation and delivery, and merchandise that is presented "floor ready" on hangers with price tags already attached [3].

In such a large and continuously changing sector, the waste problem has become a non-ignorable issue and the concept of sustainability has come to the forefront. In the European Union (EU), around 5.8 million tonnes of textiles are discarded by the **consumers** (manufacturers are not included) per year [4]. In Turkey, industrial textile wastes resulting from production are 590000 tons per year and textile wastes resulting from domestic use is 564657 tons per year. Those that can be recovered from total waste are 1155000 tons per year [5].

At this point, both the producers and suppliers and the final consumers have responsibilities and the importance of sustainability concept becomes clearer. The term 'sustainability' refers to the long-term viability of business operations and their subsequent effects on environmental and social well-being. As it can be understood from the meaning of the term, sustainability is actually contrary to the concept of trend change relevant to fast fashion in apparel industry.

II. SUPPLY CHAIN IN APPAREL INDUSTRY

The textile supply chain has a highly complex nature and consisting of multinational garment retailers (customers), garment manufacturers (suppliers) and ancillary suppliers (suppliers to manufacturers) [6, 7] that must respond to the frequent changes in product lines and styles.

As shown in Figure 1, the raw material of apparel industry passes from many production processes involving fiber production, yarn manufacturing, fabric production. While passing from these steps, natural resources (water, oil, land) are consumed, toxic chemicals are used, large amounts of carbon dioxide is generated and million tons of wastes come out (Figure 2). In order to obtain sustainable apparel production, all these steps should provide sustainability.

As apparel companies undertake the mission of sustainable design (i.e., systems that support human well-being and are compatible with sustaining natural environmental systems) they are focusing on the planning stage of the supply chain - the design phase-because that is where most decisions are made that potentially impact the entire life cycle of the

product [7]. Unlike fast fashion which is focused on quickly adapting popular styles, sustainable design incorporates reflection throughout the design process [8].

Using recycling waste can benefit both business and the environment by:

- Reducing cost of purchasing materials.
- Increasing profitability.
- Minimizing costs of disposal and treatments.
- Minimizing environmental impacts by reducing use of new raw materials and producing products from earlier one.
- Textile recycling requires less energy than any other type of recycling.
- Textile recycling does not create any new hazardous waste or harmful by-products. [9]

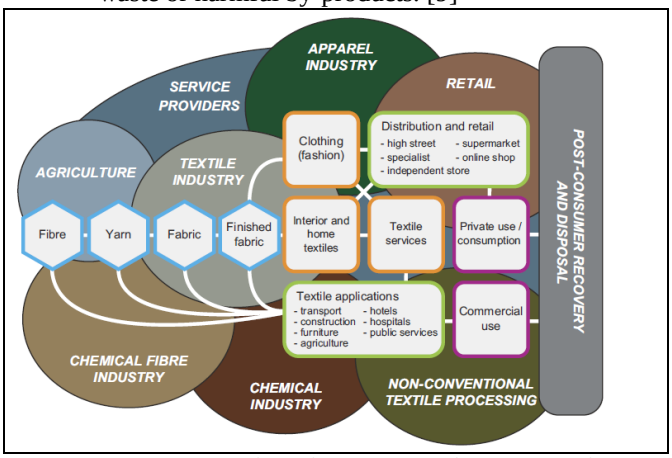


Fig. 1 Sector map and simplified influence diagram for the supply of apparel and textiles [10].

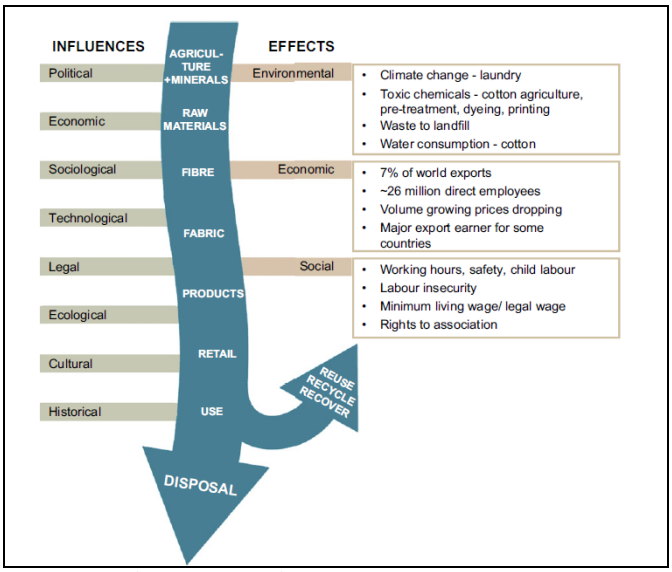


Fig. 2 Influence diagram for the clothing and textiles sector [10]

III. ENVIRONMENTAL IMPACTS OF RAW MATERIALS USED IN APPAREL MANUFACTURING

World population growth combined with the ongoing overall improvement of living standard has resulted in a steady increase of global fiber consumption. This consumption of course resulted in a higher amount of fiber wastes [11].

Textile and clothing consumption is estimated to comprise about 5% of the environmental impact and carbon emissions of households [12].

When choosing materials for garments, the material's attributes and how they suit the particular wearing practices have to be considered carefully. It is also important to evaluate the material's aging process so the material does not look old too fast [12].

Apart from all, consumers have some common misconceptions about the raw materials used in their clothes. Cotton is a natural cellulosic fiber and therefore many consumers believe it is an environmentally responsible product [13]. In fact during cotton plant cultivation water resources are exhausted and heavy pesticides are used. During the processing of cotton goods variety of chemicals are used. Although the production of wool does not involve the use of fertilizers or herbicides as in cotton production, soil erosion can occur from overgrazing by sheep if not controlled properly. The processing of wool requires the use of soap and alkaline solutions to clean the fibers and to remove grease and impurities [13]. As being an oil based synthetic fiber, polyester fiber is derived from the same materials as plastic bottles. Oil based synthetic fibers are considered to take 200 years to decompose [14]. Table 1 shows the environmental effects of some fibers used in apparel industry and in this table Class A contains the least harmful fibers in terms of environment whilst Class E contains the most harmful fibers in terms of environment.

Table 1. Environmental effects of some textile fibers [12]

Class-A	Class-B	Class-C	Class-D	Class-E
• Recycled cotton • Recycled nylon • Recycled polyester • Organic hemp • Organic flax	• Tencel® • Organic cotton • In conversion cotton	• Conventional hemp • Ramie • PLA • Conventional flax	• Virgin polyester • Polyacrylic • Modal®	• Conventional cotton • Virgin nylon • Rayon • Bamboo viscose • Wool • Generic viscose

Figure 3 is showing the recycling possibilities in terms of fiber types. Landfill is the mostly used one for especially natural fibers. But as it is mentioned above cultivation and processing of natural fibers require so much easy and considering the environmental damage, natural fibers especially the cotton is so expensive and valuable for being a landfill.

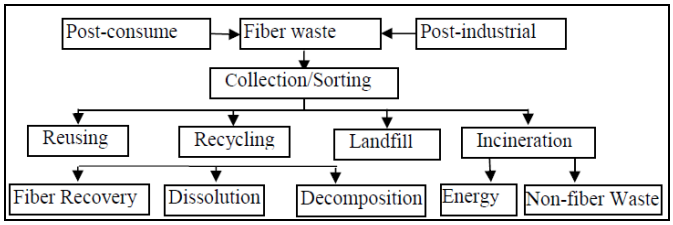


Fig. 3 Fiber waste recycling process [11]

Resusing and Fiber Recovery: Charities and some public corporations collect second hand clothes and donate them. Some manufacturers sell their second quality garments to developing countries to quite low prices. On the other hand, some companies and retailers collect worn garments and textile wastes and then recover cotton fiber from these goods. However, the reclaiming of cotton from textile wastes is not so easy. In order to recover any fiber from textile wastes, textile wastes must firstly turned into open and separated usable fibers [11]. This step is generally so complicated since the majority of textile products are blended and multi colored. Some companies, apart from apparel manufacturers, can easily use reclaimed synthetic fibers in their production lines. For example, upholstery and automotive needle punch fabric manufacturers experience an increased demand for polyester recycled fibres, for which conventional recycling processes of making reclaimed fibres can well be used [9].

Dissolution: Nylon and polyester can be separated from wastes by using solvents and this technique is called dissolution. In this technique there is no serious degradation taking place. But of course there are some drawbacks like usage of chemicals and temperature and pressure [11].

Depolymerization methods: It is used in the treatment of waste synthetic polymers. Naylon and polyester wastes can be converted into monomers or oligomers which may be suitable for reforming original resin [11].

Landfill: In the European Union (EU), around 5.8 million tonnes of textiles are discarded by the consumers per year. Only 1.5 million tonnes (25%) of these textiles are recycled by charities and industrial enterprises. The remaining 4.3 million tonnes goes to landfill or to municipal waste incinerators [4].

Incineration: Thermoplastic polymers can be converted into resin pellets by melt extrusion processing. Flax and hemp natural fibers can be manufactured into activated carbon matting via chemical activation and pyrolysis [11].

IV. PERSPECTIVE OF INTERNATIONAL APPAREL RETAILERS

Current trend in ready to wear sector is fast fashion which is based on low cost clothing collections and by its nature a fast response system encouraging the disposability [3]. With the emergence of small collections of merchandise, fashion retailers are encouraging consumers to visit their stores more frequently with the idea of 'Here Today, Gone Tomorrow'. This indicates a shorter life cycle and higher profit margins from the sale of fast selling merchandise, skipping the markdown process all together [15]. At this point, international clothing retailers have big responsibilities since they are believed to be the key drivers of the globalization of the clothing industry. They fuel globalization via global sourcing [16].

As consumers' awareness of environment increases along with the global demand for green products, major global retailers create labels claiming environmental benefits, or green labels, (e.g., Green Collections of Gap and Carbon-Neutral Lingerie of M&S) and indexes to evaluate ''greenness'' of suppliers and/or products for practicing sustainability (e.g., Sustainability Index of Wal-Mart and the Eco IndexTM of The U.S. Outdoor Industry Association) [17]. Some international retailers like H&M launch "garment recycling" campaigns and announce them with advertisements (Figure 4). Companies aiming to be 'sustainability leaders' in their sector and governments wanting to support their ambitions need a means to assess the changes required to make a significant difference in the impact of their whole sector [10].



Fig. 4 Campaign of H&M

Landfill is not a permanent solution in terms of sustainability and environment. Global retailers' eco-friendly policies and investments in their implementation demonstrate that green retailing is no longer an option, but an essential part of the business model. The green concept is related to the ecological dimension of sustainable development, which consists of its sociocultural, ecological and economic subdimensions [17].

V. CONCLUSION

Unsustainable human behaviours destroy water, land, forests and energy reserves throughout the world. Similar pictures of ecological decline could be drawn for air pollution, mineral depletion, and loss of biodiversity [18].

Recycling of textile waste gives fiber a second life in a rejuvenated life cycle and thus increases the total value of that recycled fibre. Still most of recycled fibres end up in low value products, so the development of new higher value products from recycled fibres will encourage utilization of the waste fibres and contribute to the future sustainability of industry [9].

The great task and responsibility in sustainability of apparel and fashion industry belongs to international retailers and their consumers.

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